ELEMENTS OF AGRICULTURE

FOR

PUBLIC SCHOOLS

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FOR FREE USE IN PUBLIC SCHOOLS OF MISSOURI

ELEMENTS OF AGRICULTURE FOR PUBLIC SCHOOLS.

INTRODUCTION.

Fifteen years ago the present State Superintendent of Public Schools spoke before county teachers' associations and grange meetings urging that the elements of agriculture be taught in the public schools. Since then he has seen the sentiment grow until there is a great demand for it. For five years the law has recognized it as a part of the course of study by making it one of a group of subjects from which an applicant must select one upon which to be examined for a first grade certificate, or for a state certificate. Four years ago the State Normal Schools established departments of agriculture and nature study. There are now many teachers in the state prepared to teach elementary agriculture.

In 1903 members of the Agricultural College faculty and heads of departments of agriculture in the Normal Schools attended county teachers' associations and gave instruction to teachers. The Department of Agriculture, at Washington, sent a representative, Prof. D. J. Crosby, to ten County Teachers' Associations in Missouri to present this subject to teachers. To all of these the State Superintendent is indebted for assistance in stimulating teachers. For a year there has been a demand for an outline giving more definitely what should be attempted.

No attempt has been made to give the subject exhaustive or scientific treatment. It will have served its purpose if it is helpful in leading the way to better things. Text-books on this subject have presented it in three different ways: (1) by experiments at home and in the field; (2) by studying facts as given in texts and bulletins; (3) by school gardens connected with school grounds.

An attempt has been made to combine these methods. Teachers are advised to utilize school grounds or gardens near the school as experiment stations, to have pupils experiment at home and make field observations, and to secure bulletins from the Department of Agriculture at Washington, D. C., from Missouri State Board of Agriculture, and from the Agricultural College, both at Columbia. The school

library should have copies of several good texts. See list at end of this bulletin. Appeal to the pupils' interests along all lines and enlist the co-operation of the parents.

The subject matter has not been arranged in the exact order it should be studied, nor according to logical development. Each subject should be studied at the time the material can be had and when the season offers best opportunity. Soil, roads and stock-farming may be studied during any month of school; insects, seeds and plants must be studied at appropriate seasons.

This bulletin has been prepared principally for use with advanced classes in rural schools, but it can be used to advantage in high schools.

To my assistant, Supt. R. H. Emberson, is due much credit for help in preparing and arranging the subject matter presented herein.

W. T. Carrington.

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I. STUDIES ON SOIL

1. Origin and Composition of Soil.—Soil is the upper stratum of the earth. It is composed of small fragments of rock and the remains of animal and vegetable life. The agencies which have contributed to the formation of soil are heat, cold, water, frost, animal and vegetable life. Rocks were once very hot; as the outer portion cooled faster than the inner, many of them were broken or cracked. Water entered these fissures and, freezing, expanded and caused a further breaking up. Running water, carrying sand, gravel and stones in its course, wears away the solid rock and contributes to the formation of soil. Glaciers have been great agencies in making soil. Air and moisture wear away stone. This process is called weathering. The roots of trees penetrate the opening in rocks and assist in breaking them open. Lichens and mosses grow on rocks and make a suitable bed for the seed of other plants. Decayed vegetable matter gives soil its rich black color. Innumerable insects die and their bodies add richness to the soil. Angle worms bore into the earth and allow air to enter, which improves the soil. All kinds of animal manure are of great value in building up soil. Find illustration of different ways of breaking up rocks and wearing them away. The word soil usually refers to the first six to twelve inches of the earth's surface, which is usually darker in color than the portion beneath this depth known as subsoil. In arid regions where crops are irrigated, the distinction between soil and sub-soil often disappears. Soil has no fixed depth, color nor fertility. These vary with localities. Some of the most important substances found in soil are phosphorus, potassium, nitrogen, lime, sulphur, magnesia and iron. The first three are of greatest importance. Water is always present in productive soil.

2. Kinds of Soil.—There are different kinds of soils. Sandy soils contain a large amount of sand; clay soils contain a large amount of clay; loams are composed of about equal portions of clay and sand. Loess soil is composed of extremely small particles of a sandy nature and is easy to till. Soil that contains much vegetable or animal matter is called humus. "Light soil" or "heavy soil" has no reference to weight but to the ease with which it may be worked. The temperature of soils depends largely upon the amount of water which they contain.

Wet soils are cold; dry soils are warm; very dry soils become a desert. Dark soils are usually warmer than light ones; sandy soils are warmer than clay soils. The slope of the land surface has a marked effect upon the temperature of the soil. A warm soil prepares plant food faster than a cold one. The soil serves as a root bed for plants. It serves as a support to hold many plants in an upright position.

3. Plant Food.—Much of the food of plants must be worked into the soil before it can be used. Soil holds water and furnishes it to plants; this is the basis of all farming. Soil is "worn out" when the plant food which it once contained has been used up. The most important plant foods are nitrogen, phosphorus and potassium. These are supplied by means of farm manures and commercial fertilizers or by natural soil processes. Manures make the soil richer and increase its power to hold water; commercial fertilizers are chemical compounds prepared to supply foods to plants; they carry a small amount of soluble food to the plant but they make little, if any, contribution to the soil. Cotton seed meal, dried blood and nitrate of soda, as fertilizers, furnish nitrogen, bone meal furnishes phosphorus and kainit furnishes potassium.

4. Improvement of Soil.—Wet soil may be greatly improved by draining or tiling. If water stands on the surface, the land should be drained; if it is in the soil, the land should be tiled. Tiling improves land by leading off the water, rendering the soil lighter, warmer and better for cultivation; it also allows air to pass through the soil which is beneficial. A subsoil of hard clay or "hard pan" holds water and keeps land too wet for cultivation. Land above "hard pan" can not stand drought because moisture can not rise from beneath it. In loam or loess soil, moisture at great depth will rise and feed growing crops. For this reason, loam or loess soil is well adapted for farming. Moisture may be retained in the soil by making a fine earth mulch. Land that is cloddy will not stand drought as well as land that is well pulverized. Soil is improved by planting clover, beans, peas, and other leguminous plants. Great numbers of minute organisms locate themselves on the roots of these plants, causing the formation of small knobs called tubercles. These organisms have the power to extract nitrogen from the air and give it to these plants. Study closely entire plants of clover, peas and beans. Which have longer roots? Which will stand dought better? Clay soils may be improved by sprinkling them with lime. The particles of clay are broken up, are rendered less impervious to water and can be cultivated more easily.

5. Rotation of Crops.—It is not a good practice to put the same

field in corn, wheat or other crop year after year, for sooner or later, the soil will be "worn out." Plants differ in capacity for plant food. Some obtain their food from near the surface, others from both soil and subsoil. These facts show the necessity for rotation of crops. Rotation means changing the kind of crop upon a certain field. Crops with shallow roots that feed upon the soil only, should be followed by those having deep roots feeding upon the subsoil. Cereals, or grain crops, derive nitrogen, phosphorus and potassium from the soil itself, while clover, peas and beans derive nitrogen from the air of the soil; such crops should be raised every third or fourth year. On account of growing the same crop year after year, the soil becomes infested with weeds and insects. Meadows and pastures are frequently taken by weeds. The remedy in such cases is to plant a crop that requires close cultivation. The system of rotation must be suited to the soil, the kind of farming and the circumstances of the farmer. The garden farmer aims to produce as many crops as possible during the season. He farms intensively, hence does not depend upon rotation to keep up his soil but depends upon manures and fertilizers. What advantage is clover in rotation of crops? Name some crops that are especially valuable for tillage and weed destruction. Make an outline of what you consider a good four-year rotation of crops. Write an essay on "Advantages of Rotation of Crops."

6. **Experiment.**—Notice the experiment in paragraph 42. That part of the plant which is water, evaporates when the plant dries; that part which came from the air passed back into the air when the plant is burned and that part which came from the soil remained as ash. Make the experiment and compute the per cent of each by weight. Why should not straw, stalks and other vegetation be burned? What should be done with them?

7. **Experiment.**—(a) Put a handful of some peaty soil from a low place, some ordinary soil and some ashes, each in a saucer by itself and mix with water until it becomes a paste. Put small pieces of both red and blue litmus paper in each saucer. If the blue paper is turned red, the soil is acid. Such soil should be treated with wood ashes or lime. If the red paper turns blue, the soil is alkaline and is in good condition for plants. Test a variety of soils in your district. (b) Have each pupil bring a small box of soil from his home, secured near the middle of a field. Make a classification of them.

8. **Experiment.**—(a) Put some fine clay in a tin can, some sand in another and a mixture of sand and clay in a third. Put a cupful of

water in each. Notice in which it sinks first. See how much water can be poured into each. After each has taken up all the water possible, from which can it be drained or poured off the quickest? Make a ball out of the soil of each. Which retains shape the best? Which soil is best for farming? Which will bake? (b) Fill one tin can with fine clay, another with wet sand and a third with dry sand. Set on stove and notice which gets warm the quickest. Will wet soil or dry soil warm quicker? (c) Take two lamp chimneys and tie a thin piece of cloth over each. Fill one with dry sand, the other with dry, powdered clay. Set both in a pan of water and notice how long it takes the water to rise in each. When they are thoroughly saturated, remove from the pans and notice which dries first. Which soil can be worked the sooner after a rain?

9. Experiment.—(a) Fill two cigar boxes with good, rich soil and plant with beans, peas or corn. Set one in a pan of water which nearly covers the box and keep the same amount of water in the pan. Keep each box in a warm place and give each the same attention. Note the difference between the plants. Which grew the faster? Which has the greener color? Why? Why is tiling good for land? (b) Drop a handful of soil into a bottle of clear water. Shake it up and stir slowly with a stick until it settles. Notice the difference between the soil which is at the bottom and that which is on top.

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11. ROADS—IMPORTANCE AND IMPROVEMENT.

10. Location of Roads.—A public road is a highway of travel. The land on which it is located belongs to the public. Some roads are owned by individuals or corporations. Roads are usually located on section or quarter section lines. Plat your congressional township and school district and locate the roads. Calculate the number of acres in the roads of the township; of the school district. Owners on either side of a proposed road are required, by law, to give half of the land for the road. Give the legal processes necessary in locating a new road; include the petition, the duties of the County Court, the County Surveyor and the Road Overseer (State Road Law). Read in Roman History about the Appian Way and how it was constructed. The Romans built roads that are in use to-day. The older countries of Europe have far better roads than this country has. What determined the location of roads in early settlements of Missouri? In these early settle-

ments, the most level route was selected with little regard for boundary lines. For this reason some of the old roads are the best.

11. Value of Good Roads.—A road to be permanently good must have a hard and smooth surface, regardless of weather, so that it may be easily traveled at all seasons. A dirt road is one that uses the natural surface of the ground with no other attempt at improvement, except draining and grading. In locating roads, steep grades should be avoided. The grade or rise in a road should never be more than seven (7) feet in one hundred. If the steepness of the grade increases, the weight of the load must decrease. On a rise of one foot to the hundred, a good horse can pull 900 pounds; on a rise of ten feet to one hundred, he can pull only 250 pounds. These figures show how important it is to avoid very steep grades. With a carpenter's level and measuring line, determine the grade of some of the steepest hills in the roads of the neighborhood and calculate how much a good team can pull up each. Teachers should take great pains to show pupils how to make such measurements and should insist on accurate calculations. What is the value of good roads? How does your community regard them? What is it doing to improve the roads? Have full written report from every pupil on condition of public roads in the district.

12. Road Drainage.—Good drainage is as important as good grading. Wet spots soon become mud holes which prevent hauling heavy loads. Wet spots should be tiled or underdrained. The surface water should be carried off by open ditches which may be made at either side of the road. The center of the road should be higher than the sides in order to cause the surface water to run off. Water is the chief cause of bad roads, whether it is upon the surface or in the soil. Weeds should not be allowed to grow in the road because they make the road bed soft and yielding. When cut or allowed to die in the fall their roots hold moisture. A good road must have a firm bed; for this purpose neither mud nor sand will answer. Road beds are rendered firm in several ways. A common method is by graveling. Since loose gravel makes a heavy road, it should be packed with a roller. Large unsightly ditches may be prevented by putting in a covered tile drain on each side of the road and leaving a shallow ditch above it. Gravel should be screened before putting it on roads; the coarser portion should be put down first and the finer on top. What is tiling? How made? How used? Observe some good artificial drainage and write a description of it.

13. Artificial Roads.—Two kinds of artificial stone roads are the

Macadam and the Telford. They take their names from the inventors who were two Scotch engineers. A Macadam road is made by first putting down a layer of broken rock, none of the pieces to exceed three inches in diameter. The layer is rolled and packed. On this layer is placed another of smaller rock which is also rolled and packed. Lastly a layer of finely crushed rock is put on which is wet and heavily rolled. The Telford road is very much like the Macadam except that the first layer is one of flat stones laid in somewhat regular order. Stone roads will last for years and it will cost but little to keep them in repair. There should be a dirt track on both sides of a stone road for use in dry weather. Why? Early settlers in lowlands and swamps, made roads of poles of uniform size, by laying them side by side across the road. This gave a hard but rough surface. They were called "Corduroy" roads. Find out if there are any gravel roads in Missouri. Where are they? How are they kept up?

14. Good Dirt Roads.—How to make the best dirt roads is the great road problem in Missouri. Roads were worked in earlier times with picks, shovels and hoes; later with plows and scrapers; following these came the grader. The grader is an expensive machine, and, on account of the number of horses required to draw it, it is not easily managed. Mr. D. Ward King of Maitland, Mo., recommends dragging. The drag is made by pinning the two halves of a split log together, thirty inches apart, both flat sides facing the team. An old wagon tire should be fastened on the front piece and a chain or heavy wire fastened eighteen inches from each end with which to draw it. The team should be so hitched as to drag the dirt towards the middle of the road. Some of the advantages of dragging are: the road is made smooth and water flows off easily; the old trail is destroyed and a new one is made on a different part of the highway; ruts are filled up and weeds are killed while small. The drag should be used after a rain. The road bed will soon become hard and smooth. The oftener the drag is used the better. A half mile of road can be worked in a few minutes by a man and one team; hence, the method is a very inexpensive one. Where the method of dragging has been employed, it has proven very satisfactory. Get some patron to make an experiment of road dragging and have pupils observe results and make note of every point of advantage or disadvantage. Write to Secy. Geo. B. Ellis, Columbia, Mo., for bulletin on road making.

15. Experiments.—(a) Fill one quart tin can two-thirds full of sand and another two-thirds full of clay. Scoop out a hole in each large

enough to hold half a tea-cup of water, fill the holes with water and set away for several minutes. Will clay or sandy roads dry quicker? Which will hold water better? Which will make the better road surface to turn water? (b) Have pupils draw map of school district on scale of four inches to the mile. Designate all public roads by double lines, farm houses by small circles and school house by small square. After all have drawn maps, teacher should point out mistakes and have maps reproduced. Some pupil should then draw it on black-board on scale of one foot to the mile. In this connection teach congressional township, sections of land and other subdivisions. Teach how to describe land and make many problems concerning land measuring.

16. Influence of Roads.—Good roads exert great influence on the community. With them better schools, better churches, more money and more business are possible. The work of country schools depends largely on the condition of the roads. When roads become very bad, many children are prevented from attending school and sometimes the school is closed on this account. For this reason, many people leave their farms and move to town. Regular church attendance in the country is dependent on good roads. Social life is also influenced by the condition of the roads. In many localities the women and children are cut off from any associations for weeks. Literary societies, debating clubs and reading circles are impossible at certain seasons on account of bad roads. In many communities the farmer spends too much of his time in taking his produce to market. With good roads he could accomplish more in less time. The Rural Free Delivery is exerting a beneficial influence upon road conditions. The roads must be passable at all seasons before a route is established. With more good roads, this system will be extended, and with it the Department of Agriculture will send the Daily Weather Reports, which will bring useful information to the farmer. Every step taken to make the way easy to school, to church, to postoffice, to market and to the homes of neighbors is a step taken to prevent the building of towns and cities out of the wreck of country homes.

17. Road Laws.—The county court has power to classify public roads as first, second and third class. First class roads lead to the county seat; second class roads lead to other cities and towns of the county; all other public roads are third class. All public roads shall be not less than thirty nor more than sixty feet wide, to be determined by the county court. The county surveyor is ex-officio road and bridge commissioner. He surveys new roads and superintends the construction of

bridges, under the direction of the county court. A petition for a new road must contain the names of at least twelve property holders; it must specify the beginning, course and termination of the road. Road overseers are appointed by road commissioners or elected by resident tax payers of the road district. They are paid two dollars per day. Poll taxes may be paid by working the roads. A man and team are allowed two dollars per day while working out poll taxes. Work on the public roads must be done between the first day of March and the first day of September. When vehicles meet on the public roads, each must turn to the right according to law. It is a misdemeanor to run horses, to shoot at marks, to destroy mile posts or guide boards on the public roads, or to obstruct the public roads in any way. In moving engines, exceeding one ton in weight, over culverts and bridges, planks not less than one foot wide and three inches thick, must be laid. Persons moving engines threshing machines, mowing machines, etc., when meeting any one on horseback or in a vehicle, must stop and remain standing until the person on horseback or in the vehicle has passed. The penalty for failure to do this is not less than five nor more than one hundred and fifty dollars.

III. STUDIES ON SEEDS AND RELATED SUBJECTS.

18. Germination of Seeds.—Plants, with few exceptions, spring from seed. The germ or young plant is surrounded with starch and sugar on which the young plant feeds before nourishment is supplied by the soil. The germ is composed mostly of protein substances which are especially valuable for food. Germination is produced by heat and moisture. By a chemical change, the insoluble substances are rendered soluble, upon which the young plant feeds before issuing from the seed. When the seed begins to sprout, the radicle or root appears first. The root enters the soil. The stem or plumule appears next and turns towards the light. When the soluble material of the seed is used up, germination ends; then the plant feeds upon the soil and air, and the seed is of no further use. Plowing, harrowing and rolling the soil before planting is for the purpose of improving heat and moisture conditions which aid germination, and for producing a seed bed in which young plants may easily take root.

19. Vitality of Seed.—A seed must contain a living germ or it will not sprout. Only those seeds having the strongest vitality should be

planted. Corn, wheat, oats, potatoes, bluegrass and clover often give poor yields on account of weak vitality of the seed. Seeds lose their vitality with age. Beans, peas and corn are good for two years; lettuce and radishes for three years; melon and squash, six to eight years. It is well to select the largest, plumpest corn, wheat, oats and clover for seed; the yield will be much larger; it will be less affected by drouth, poorly prepared soil and other unfavorable conditions. In sowing very small seeds, such as timothy and clover, it is supposed that about one seed in five or ten will grow. This loss is due to drought, poorly prepared soil and lack of vitality in seed. Seeds should be selected that have grown on soil of about the same fertility as that in which they will be planted. Make collection of seeds of all kinds of grains and grasses grown in the district; of fruits and of garden products. Small bottles of uniform size, properly labeled, should contain samples of seeds. Test their vitality.

20. Experiment.—(a) Fill two tin cans with clean sand. Plant in one a dozen plump kernels of wheat; in the other, a dozen shrunken kernels. Water from time to time. Which kind of wheat sprouted the quicker? Which grew more rapidly? Which plants were the larger? What lessons learned from this? (b) Put in bottom of a deep dinne plate or a pie pan four thicknesses of cotton flannel. Sprinkle with wheat, keeping count of the number of grains. Cover with two thicknesses of cloth. Keep in warm place. (Sand may be used instead of cloth.) Cover top of pan with a pane of glass. Keep cloths moist. Observe how many of the seeds sprouted. What per cent? About 95 per cent of good seed wheat should grow.

21. Parts of Seeds.—(1) Outer parts.—(a) Hilum or scar, the joint where the seed was attached, sometimes called the eye; (b) micropyle, minute opening near hilum. (c) Seed Coats, testa or outer coat and tegmen or inner coat. (2). **Inner parts**—(a) Cotyledons, thickened leaves in which nourishment is stored. When there are but two, the plant is a dicotyledon; when but one, a monocotyledon. (b) Plumule, small terminal bud lying between the cotyledons or embedded in it when there is but one. (c) Radicle or root within seed coats. (d) Embryo, the small plant within the seed coats.

22. Experiment.—(a) Soak some corn, beans, peas, squash and pumpkin seed and find these parts. Measure length and circumference of some of these seeds; place in a germinating pan, described in paragraph 20 (b). Remove carefully every two days and measure. Make a rece ord of all your observations. (b) Secure a dozen plump grains of seed-

corn. Trim half dozen of them down leaving only small amount of seed, but preserve the germ. Plant the dozen in a box. Keep soil moist but not hot. Observe the difference in the growth. What lesson does it teach? (c) Test the germinating power of some kernels of seed corn. Repeat several times and compute the average. What per cent is good? Discover, if possible, why some kernels do not germinate. Test the vitality of many different kinds of seed.

23. Corn Planting.—Corn is a general term which embraces maize oats, wheat, rye barley and rice. Cereal is another term including the same grains. In ordinary use, corn means Maize, or Indian corn. This plant was first discovered in America. Its native home was probably Mexico. Name the great corn producing states which form the corn-belt. A rich, loose warm soil is best for corn. A shallow or worn-out soil should not be used. Plow deep and make the surface mellow before planting. Make drawing showing the different ways of planting corn. Good seeds are necessary and should be selected with care. Examine a dry grain of corn on both faces. Notice the grooved side; the yellow outer portion is the endosperm; the depression is the embryo or germ. Which is the hardest part? Soak for 24 hours and note the change. Compare the parts of a grain of wheat with those of a grain of corn. Why will seeds not sprout in soil that is very dry? In soil that is full of water? In soil that is too cold? If planted too deep?

24. Corn Growing.—Count successively one hundred stalks in each of three or four corn fields. Note how many are barren; how many have more than one ear to the stalk; how many have just one ear to the stalk. Find per cent in each case. Do all ears grow the same height from the ground? Where does best corn grow on the stalk? Seed corn should not be selected from a field where there are many barren stalks; why? Is it best to select seed from a stalk bearing one ear or two? Why? Measure several best quarter acres of corn in the district. Test each as to number of stalks, number of ears, amount of shelled corn, percentage of corn to the cob. Note all differences in soil, in seed, in cultivation and discover the reasons. May there be too many stalks? Too few? The per cent. of broken and barren stalks should be as small as possible.

25. Experiment.—(a) Plant a small patch of corn, using for seed, corn that grew one ear to a stalk; plant another patch of the same size in another part of the field, using as seed, corn that grew two ears to a stalk. Cultivate both in the same way. When the corn is gathered, count the ears and weigh the corn. Send the results in writing to

your local paper. (b) Plant five plats of two rows each, twenty feet long and treat each differently as follows: (1) Do not cultivate, let weeds grow; (2) Mulch with straw; (3) Give shallow cultivation, not deeper than three inches and at least five times during the growing season; (4) Give deep cultivation at least five inches and very close to the roots; (5) Prune roots with a sharp knife, six inches deep, ten inches from stalk and cultivate five times. Note result at gathering time. This experiment shows that the roots of growing corn should not be disturbed or broken.

26 Corn Judging.—Ears of corn should be well proportioned, the butts and tips full, the rows straight and the kernels uniform. Bring to school an ear of corn on which the rows have a spiral arrangement; bring one on which a beak is found on the crown of the kernel. These are signs of degeneracy. No such ears should be used for seed. Rows of corn on the cob should not be too far apart. Bring samples to school. Shell off three or four rows. Are the kernels dented on crown? Are they uniform in size or appearance? They should be plump and full at the tip and should have large germs. Break several ears of corn and note the relative amounts of cob and of kernel. Short grains are not best. Why? Grains very long in proportion to size of the cob, are not so hardy. Bring to school an ear of corn that is not matured at the butt; bring one that is not matured at the tip; bring one on which there is no regularity of the rows of kernels. Do these characteristics indicate weakness or strength?

27 Corn-Contest.—(a) Get every boy who is twelve or more years old to compete in contest to see who can grow the best eighth of an acre of corn (5 rds. by 4 rds.). Secure the same seed corn for all. Some interested patron who is a successful corn grower may furnish it from his own growing or he may secure it from some one who has a highly improved variety of corn. Every boy should select his own land, prepare it, plant and till it by himself. Some good judge of corn should be selected to inspect every entry in the contest sometime the next September or October and make detailed report. If some interested party would offer a prize or offer to pay high prices for the best corn raised, it will stimulate more pupils to try and all to greater effort. Report results of contest to the county superintendent of schools and to the local papers. (b) Have every pupil bring to school the best three ears of corn that he can find. Invite patrons to the contest. Secure the best judge who is not interested in any contestant to determine who has selected the best corn and to report on the points considered. This contest may

be converted into a fruit, grain and vegetable show and held sometime about Thanksgiving. County Superintendents may provide a contest between schools at the county teachers' associations.

28 **Seed Corn.**—Seed corn should be gathered in the field. Why? Poor ears should be rejected. The butts and tips should not be used for seed. Why? Ears should be assorted according to size of kernel and kernels of uniform size planted together. Why? Plant three kernels in a hill. Put some of the large kernels in your planter and work the lever one hundred times. Note how many it drops each time. What per cent of the hills had three grains? What, more? What, fewer? Discover the necessity of regulating the planter to the size of the kernels and of having kernels of uniform size. Seed corn should be put in a well ventilated place to dry thoroughly. It can then be put away for use and there will be no danger of freezing. Write an essay describing good seed corn.

29 **Observation and Field Work.**—Is the upper portion of a young corn plant stalk or leaf? Note shape of young leaves. Note changes as they grow older. Note division of leaf into blade and sheath, relative length and position of each. Where is the blade the fullest, at edge or at mid-rib? Observe a field of corn when blown by the wind and see if you can give a reason for this. Note what provision is made to keep water from running between sheath and stalk. Cut a stalk crosswise. Where does its strength lie? What do you notice in the pith? Note groove on the node. In which node is it deepest? Which nodes are the shortest? The thickest? The nearest round? Give reasons. Note the brace roots of the stalk. Give their uses. Note carefully how deep the roots penetrate the soil; how much they spread. Why do corn leaves curl during drought? Make drawing of an entire corn plant two weeks old; of one, two months old; of one, fully matured. On which part of the stalk do the stamens grow? the pistils? If the tassels were cut off, what would result? Compare corn with other cereals as to length of time it may remain on stalk after ripening. What is fodder? How harvested? How taken care of? How fed? What value in proportion to corn? What is ensilage? The pith of the stalk is used for what? The husks? Some varieties of corn are known as high protein, others as low protein. What is meant? For what is each best? Write essay on uses of corn.

30 **Experiment**—(a) Make a small bed and lay off three rows in it. In one row plant kernels of corn taken from the tip of the ear; in another, kernels taken from the middle, and in the other, kernels taken

from the butt. Note the relative growth made by each. State some conclusions drawn from this. (b) Secure box two feet square or larger. Fill with good soil. Plant dozen grains of corn, of wheat and of beans, one inch deep. Same number three inches deep. Same number six inches deep. Find average length of time for each kind of plant to appear. How deep should each kind be planted? How does depth of planting affect germination?

31. Experiment.—(a) Measure a bushel of corn on the cob; shell it and note how much of its original space it occupies. What deductions should be made for cob when buying corn by measurement? When buying by weight? (b) Cut a bundle of green corn and weigh it. Strip off blades and corn and weigh stalks, blades and corn separately. Let them dry thoroughly and weigh again. Give per cent, of loss in each. What was lost? What practical lesson learned from this?

32. Problems and Observations.—(a) Careful observers say that it takes 270 pounds of water to mature one pound of dry corn. If a farmer produces two and one half tons of dry corn per acre, how many tons of water will it require? An ordinary pail holds about twenty five pounds. How many pails will it take to the acre? How many gallons to the acre? (b) Make observations and study bulletins on enemies of the corn plant. Make full notes on several enemies of the corn plant and remedies for each.

33. Wheat and Its Uses.—(a) Have pupils bring a handful of wheat to school for study. Note whether the grains are the same size, shape, color. Cut a grain cross-wise; note the germ which contains much protein substance; note the starchy matter. From which portion is the finest flour made? Of what use is the skin to the germ? Of what use is it commercially? Chew a mouthful of wheat; a part is soon dissolved; part remains. What dissolves? What is the remaining part? Write a description of a grain of wheat, and of its parts. (b) Learn the different processes through which wheat passes in milling. What is bran? Middlings? Shipstuffs? Discover the relative value of each as feed for stock. To what stock feed each? How? Name different grades of flour and tell uses of each. Write an essay on the different uses of wheat.

34. Observations on Wheat.—How many bushels of wheat should be sown on an acre? Tell different ways in which wheat is sown. When is wheat sown in Missouri? When in Minnesota? Name three ways in which a growing wheat crop may be damaged. How prevent damage in each case. Write an essay on preparing soil for sowing

wheat. Notice the heighth of wheat when it begins to head. Compare this with the height when full grown. Notice when the grain begins to ripen. When ripe, what difference? Note arrangements of seed in the head. How many seed in head? Count seed in a dozen heads and average. Name the different methods by which wheat has been harvested, beginning with the earliest and concluding with the latest. Give in the same manner, the different methods by which wheat has been threshed. Why do some farmers stack wheat? Name uses of wheat straw. Give the bad results from cutting wheat before it has ripened. The results from letting it remain too long before cutting.

35. **Wheat Problems.**—(a) How many bushels of wheat were grown on your home farm last season? How many bushels were grown in the school district? How many acres were sown on your home farm; How many sown in the district? What was the average yield per acre on your home farm? The average in the district? How many days' work to prepare soil? How many to sow wheat? How many to harvest? How many to thresh? How many bushels of wheat to the day's work? (b) Teach pupils how to measure land and determine areas. Pupils should learn number of acres in the different fields they know and keep records of yield from year to year. There can be no better arithmetic for future farmers. (c) Measure your wagon box and tell how many bushels of wheat it will hold. A cubic foot holds about four-fifths of a bushel. How many bushels of wheat will your school room hold? What is it worth at the present market value? How much fine flour will each make? How much of each of the other mill products?

36. **Worth Knowing About Wheat.**—(a) Wheat was first probably grown in Mesopotamia. It was grown in Palestine and Egypt in very early times. It was brought to America soon after the discovery by Columbus. Today, the United States produces more wheat than any other country. (b) Locate the wheat producing districts of the United States. Where are the largest wheat farms? The largest flour mills? What is meant by wheat passing through a "sweat?" Name the largest wheat markets in the United States? Notice the quotation of wheat, in St. Louis papers at least twice a week, for a month. Compare it with the price of the local market. What grades of wheat are usually sold in your local market? (c) Put a pint of wheat in a small box or can and sprinkle about a half tea-cup of water over it. Cover and set away for a few days. Notice the effect. Why does dampness injure the value of wheat? What lessons do we learn relating

to the care of wheat from this? (d) In what way is straw used for fuel? For shelter? For clothing? For food? Carefully prepare a written statement of the results of all experiments and observations on wheat.

IV. STUDIES ON PLANTS.

37. Parts and Classification of Plants. The parts of a plant are root, stem, leaves and flower. Every plant must care for two things: (1) its own support (nutrition), (2) the production of other plants like itself, (reproduction). Each part of a plant has a special function or work to perform. Some plants are green, some are not. The green coloring is due to chlorophyll or plant green. It is generated in the light only. Plants containing chlorophyll are able to manufacture their own food out of water, soil materials and gases. Plants that do not contain chlorophyll are not able to manufacture their own food, but are dependent upon other things just as animals are. An association of plants living together under similar conditions forms a plant society. The things that influence the growth of plants and cause them to form societies are water, heat, soil and light. Discover a society of plants due to water; one due to heat; one due to soil; one due to light. Name the plants of each society. What is an annual? A biennial? A perennial? Name two of each.

38. Roots.—The uses of roots are (1) to support or prop the plant, (2) to absorb plant food from the soil. The tap root of trees penetrates the earth many feet. Why? Notice the small hairy roots found on nearly all plants. Give their uses. Roots need air; if covered with water, the supply of air is cut off. Give an example of water roots, air roots, clinging roots, prop roots. Name a dozen roots that are used for food. Examine roots of many grains, grasses and weeds and list them as "wet weather plants" and "dry weather plants." How do their roots differ?

39. Stems.—The stem is that part of the plant which grows above the root and supports the leaves, flowers and fruit. Some stems grow under the ground. Only the leaves of such plants appear above the ground. This underground position is a good one for protection against cold or drought. Give several examples of this kind of stem. Some plants are procumbent; they lie prostrate on the ground. There is economy in building material in these plants, for it is not necessary for

them to be so rigid as to stand. Give several examples of this class. Floating stems are found in water. They are supported and stand erect in water but collapse when taken out. Give several examples of this class. Climbing stems are numerous. Some climb by twining about their support; some, by putting out tendrils to grasp the support; others by sending out suckers to act as holdfasts. Give several examples of each. The erect type is the most familiar. It is the type common to some of the smallest flowers and shrubs and also to the largest trees. Stems tend to support their leaves in such a way that they may receive light. Notice different kinds of trees and see if the branches are arranged with that end in view. An important function of stems is to conduct moisture and plant foods, absorbed by the roots, to the leaves, flowers and fruits. What is sap? Give uses of sap in commerce. What is sap wood? Heart wood? Collect a great variety of stems and study their characteristics such as the grain of woods, rings denoting age, pith and its purposes. Name a dozen uses that man makes of the stems of plants.

40. Leaves.—The principal parts of a leaf are blade, stalk or petiole, and two little leaflike bodies on the stalk, called stipules. Leaves have a characteristic green color. This color is due to light Plants that grow in the dark do not have this green color. Name some. Place a green plant in a cellar for a week. What happens? Put a board on the green grass for a week. Notice results. Why are not both sides of a leaf alike? Leaves serve several purposes. They take in carbon dioxide of the air and prepare the carbon for plant food. In dry climates, leaves are very thick. An example of this is the cactus. Give reason for this. Some leaves are covered with spines; why? Why do the leaves of the dry regions of Australia assume a vertical position? About half of the dry weight of a plant is carbon. How is it taken into the plant? The nitrogen of plants is obtained from both the soil and air. The seed contains more nitrogen than the leaf or stalk and is therefore more nutritious. The color of a plant determines its vigor which is due to iron taken from the soil. Name a dozen leaves that are directly useful to man. What effect will dust and smoke particles have on green leaves?

41. Experiment.—(a) Put a green leaf into a glass of water, expose to light and notice the bubbles that rise. They are oxygen. Whence did the bubbles come? Put the glass in a dark place and notice the result. (b) Take a good vigorous leaf with a long stem; pass the stem through a hole in a piece of card board and cover a glass filled with

water with the cardboard, letting the stem of the leaf rest in the water. Place an inverted glass the same size as the first, over the blade of the leaf; the card board should be wide enough to cover the mouths of the glasses. Notice for moisture in the inverted glass. State where it came from. Do leaves exhale moisture?

42. Experiment.—Cut a large bundle of weeds, wrap in paper or cloth and weigh. Deduct the weight of paper or cloth. Put away and when weeds are thoroughly dry, weigh again. Is there a gain or a loss? How do you account for it? What has been lost? Put the dry weeds on a large stone, piece of tin or brick walk and burn. Weigh the ashes. Give difference between weight of dry weeds and ashes. How do you account for the loss? Try this experiment with several kinds of plants and note variation in percentage of ashes. What lessons learned from this?

43. Relation to Soil.—Plants affect the soil. Their roots penetrate the crevices of rocks and assist in the work of disintegration. Decayed leaves and stems form a large portion of the rich, black soil. The roots of certain plants as clover, alfalfa, cow peas and soy beans, enter the subsoil and bring up nitrogen, phosphorus and potassium. The roots of grasses hold the soil together and prevent it from washing. What grasses are best for hill sides? What grasses grow best in your community? Why? Why will not others grow there just as well? Study the roots of wheat, corn, clover, cow peas. Compare them. Note difference. Do they support or prop the plant or do they supply it with food? Notice the depth at which they enter the ground. Notice how much ground they spread over. Study the stalks of these plants. Compare them as to position; as to length. Cut the stalk crosswise. Notice it carefully. Which part conducts the plant food from the ground? Compare the leaves of each. Which would stand drought best? Why? Notice surface of leaves. Make note of difference.

44. Position of Buds.—Make a collection of twigs from apple, peach, pear, elm, hickory, walnut and other trees. Notice the arrangement of the buds; are they opposite or alternate? Is there a terminal bud? If so, compare it with the lateral buds. Notice for rings around the twig. What do they tell or indicate? Notice the leaves and buds on the branch of an apple. How many leaves at a place on the last year's growth? On the previous year's growth? Notice relative position of leaf and bud. Are all buds found in the axil of leaves? Notice for young shoots or short lateral branches. On which year's growth do they appear? From what did they spring? Notice buds and leaves on

the tree and see which is the larger, those that have plenty of room and sunlight or the reverse. Notice if the largest buds are found on any particular part of the twig. Are apples formed at the side or end of a twig?

45. Kinds of Buds. The arrangement of leaves in a bud is called vernation. Some are arranged alternately; others have opposite arrangement. Cut an apple bud crosswise and notice the arrangement. Examine a bud closely and see if a clump of knobs is found in center; if so, it is a fruit bud. If, instead, there is a group of slender points, tiny folded leaves, it is a leaf bud. See if you can tell a fruit bud from a leaf bud, from external appearance. With the point of a knife or pin take off the scales that cover the buds. Notice color of scale leaf, the difference from a foliage leaf; give cause of difference. Leaves of buds are close together and overlap. Give the reason for this. Examine twigs of different fruit trees and make written statement of your discoveries.

46. Experiment. Collect twigs of oak, hickory, willow, soft maple and lilac. Put in glass of water and keep in warm place, if weather is cool. Make a note of the order in which they are affected by the water. What effect do you notice? After they have expanded for several days, notice which are leaf buds and which flower buds. Cut some fruit buds cross-wise and note the appearance of the young fruit. Put some buds in a mixture of salt and ice; let them remain at least six hours; then take them out and keep in a moderately warm place. Examine the young fruit again.

47. Growth of Twigs. —A twig that bears fruit does not increase in length. Why? A dormant bud does not produce leaves or flowers. If other buds are destroyed, dormant buds become productive and cease to be dormant, a wise provision in case of emergency. Study a number of apple twigs; notice the rings and determine the age of each part of the branch; notice the leaf scars, the size of the buds, the lateral branches and dormant buds. Trees having terminal buds, make a definite growth each season; others make an indefinite growth. This has a definite effect upon the mode of branching. The young tender buds on trees of indefinite growth are easily killed, hence the new branches must spring from the stronger buds near the base of the branch. This mode of branching gives to trees their bushy aspect. Observe some trees or shrubs of this nature and write a composition giving result of observation. A node is the point on the stem where the bud or leaf is attached; an internode is the interval between buds or branches. When

more than one bud develops at a node, all except the one in the axil of the leaf are supernumerary or accessory. Adventitious buds seem to appear by chance, sometimes on roots and sometimes on branches, elsewhere than at leaf axils. They appear readily when the plant has been injured by a wound. Dormant buds may lie dormant for months or years and then develop into a branch. Why do sprouts start from stumps when they did not grow when the tree was standing?

48. The Character of Trees.—Study twigs from walnut. Note little oblong cork-like spots that dot the surface of a twig. They are called lenticles. They are pores through which a small amount of air passes to the inner parts of the stem. Look for them on the peach and cherry trees. Study twigs of elm and hickory. Note arrangement of buds, the leaf scars, the vernation. What special provision is made for protection from cold? In tropical forests, trees do not develop bud scales. Why? Make written report on this study. Compare the bark of young twigs with that of the older portions of same tree, as to color, thickness, roughness. On which would extreme cold have the greatest effect? Will young trees suffer more than old ones from cold? From drought? Why in each case?

ORCHARDING AND GARDENING.

49. Site for Orchard.—A gentle eastern or northeastern slope is desirable for an orchard site. Timber land is better than prairie. Trees grow best in loam or loess soil, but those grown on clay soil stand cold better. Land should be plowed deep and well pulverized before planting. Plow in "lands" so as to make an open furrow where each row of trees is to be set. After the trees are set, back furrow so as to make the furrows midway between the rows of trees. This gives a deeper cultivation under the trees and drains the water from the trees. If the soil is lacking in fertility, it should be manured before plowing. Unleached wood ashes are excellent for an orchard. If the land is wet, it should be drained or tiled; subsoiling will afford temporary drainage in clay soil. When possible, the site should be more elevated than the immediate surroundings since free circulation of air prevents injury from late spring frosts. This is especially applicable to peach orchards.

50. The Apple Orchard.—Apple trees are sometimes planted one rod by two rods apart. When they begin to overlap, they are cut out to two rods each way. Sometimes they are planted 32 by 40, or 40 by

40; then it is possible to grow corn, beans, potatoes, or other crops between the rows. The cultivation of these crops holds moisture in the soil and the trees become more healthy and vigorous. Wide rows afford freer circulation of air and more sunshine, both of which are necessary to well-developed and higly colored fruit. Small grain should never be grown in an orchard. Plat a two acre apple orchard with the different kinds of planting described above. Early spring is considered the better time for planting. Strong, stocky trees, one or two years old, should be selected. Trees in which the trunk divides into sharp forks, split easily and should not be selected. Before planting, the top of the tree should be cut to correspond to the roots. The tree should lean a little to the southwest in order to stand against winds; it should be planted about one inch deeper than it grew before transplanting. The ground in an orchard should be plowed every year until the trees begin to bear. It may then be sown with red clover which should be turned under every two or three years. If trees are planted 40 feet each way, how many will there be on an acre? .If two rods each way, how many to the acre? If they bear 8 bushels to the tree and sell for 35 cents per bushel, how much will an acre be worth in each case?

51. Pruning Trees.—Pruning should be done while trees are young; they are easier to shape and healing is more rapid. The best time for pruning is early spring. Care should be taken in this work; the shape and nature of the trees must be considered; the object is to admit sunlight and air and to prevent too much wood growth. Should pruning be done close to the body of the tree? Will the healing be quicker? Give the object of pruning so far as the fruit is concerned. Note the size of fruit on a tree that has never been pruned. Some allow apple trees to branch 4 or 5 feet from the ground; others, 2 or 3 feet. Give the advantages of high branching; of low branching. Cut off branches at different distances from the main stem, some close, some one inch, some two inches. Cut some parallel to main stem and some square across the branch. Observe late in fall and see if scars have healed. Observe second year for scars. Make full notes on "pruning." The enemies of fruit trees are the borer, bark louse, aphis, caterpillar, codling moth, canker worm, bitter rot, leaf blight, scab and rust. (1) Insects may be destroyed by using a kerosene emulsion. To make it, dissolve one-half pound of soap in one gallon of soft water, add two gallons of kerosene and from ten to twelve gallons of water. Use with a spray. (2) For leaf blight, bitter rot, scab and rust, use a spray called

Bordeaux mixture. To make it, put six pounds of copper sulphate in a cloth bag and suspend it in an earthen or wooden vessel containing six gallons of water, until the sulphate is dissolved; then dissolve four pounds of quick lime in an equal amount of water and add enough water to make forty gallons of the mixture. (3) The San Jose Scale is one of the worst enemies of an orchard. It is a very small insect, but it multiplies so rapidly that it is to be dreaded. A vigorous spraying of a strong kerosene emulsion may check them, but if there is any doubt about killing them, it is better to burn the tree. Examine and describe each of these enemies found in the district.

52. **Observations.**—How protect young trees from mice and rabbits? When is it necessary to give such protection? In gathering fruit, care should be taken not to break the stem nor bruise the skin. The fruit should be packed tightly in boxes or barrels and kept in a cool place. Pack a small box with some winter apples. Put the box in a dark cool place. When the weather turns cool, wrap the box carefully to keep it dark and put in a place where the apples will freeze. Let it remain until late winter or spring; open and notice how many of the apples are sound. Make a list of ten best varieties of apples grown in Missouri. What special merit has each? What are best qualities for commercial apples? What for home use? How may cider be kept sweet? Write an essay on the different uses of apples.

53. **Propagation.**—Give pupils some training in the mechanics of grafting and budding. The teacher may secure help from some experienced nurseryman or orchardist. Encourage pupils to make grafts at home and set them out. In grafting, what are the stock; the scion; whip grafting; cleft grafting; budding; cutting; layering? Name a fruit that is propagated by grafting; by budding; by cuttings; by layering. Send to Agricultural College, Columbia, Mo., for Bulletin on "Plant Propagation."

54. **Grapes.**—Tell how soil should be prepared for grape planting, give method of planting, distance of rows apart, distance of plants in rows. How old should vines be when set out? Which are the best fertilizers for a vineyard? How do grape vines climb? Note arrangement of leaves and blossoms; compare them with other leaves and blossoms that you have studied. Give the method of pruning in order to produce the best fruit. When should pruning be done? What protection should be given for winter? How have the tame varieties of grapes been produced? Name some of the best varieties. What is the object of "bagging" grapes? Tell how grapes should be picked for market.

What is "girdling" a grape vine? Why is it done? Tell how grape vines are increased by cuttings; by layerings; by grafting. Make some cuttings and some layerings. Note which takes root in the ground first; which grows the best. Tell how to make a grape arbor. Tell how wine is made.

55. **Berries.** Are strawberries annuals, biennials or perennials? When should they be set out? Give the method of setting out; distance of plants apart; distance of rows apart; what kind of soil is best? Tell how to prepare it. How cultivate them? What provision should be made for the winter? Study strawberry blossoms. Find some that have pistils but no stamens; find some that have both pistils and stamens; What caution is necessary in selecting plants? Name some of the best varieties. Compare leaves and blossoms of strawberry, apple and wild rose. Note how leaves are arranged on the branches; at what time the blossoms appear. Cut a strawberry lengthwise, look for the seed. What is the part that we call the berry? Tell how strawberries should be picked, assorted, boxed and marketed. Study the raspberry following as far as possible, the plan of study of the strawberry. Note similarities, differences of stems, blossoms and fruit. Name varieties of raspberries that are grown in your community. State chief differences between red raspberries and black ones (1) as to the fruit; (2) as to methods of propagation. Which will spread the faster? Why? Have pupils bring roots of both the black and red raspberries to school and compare them. Note which produces the greatest number of shoots. Tell why these should be kept back. Study blackberry in similar way.

56. **Home Garden.** The garden should be near the house. If possible, a loamy soil should be selected and well fertilized. It should be well drained. A hedge of spruce or other trees will serve as a wind break to protect the vegetables. The ground should be plowed deep, early in the spring, and harrowed thoroughly. Plant rows three feet apart across the slope so as to prevent washing and ditching and to conserve soil-moisture. Mark where each kind of seed is planted, by putting a flat stick at the end of each row with the name of the seed written on it. Put the early vegetables in one part of the garden, the late vegetables in another. Corn and potatoes should be planted adjacent as they require about the same tillage. Plan to cultivate with horse and plow. Begin cultivating soon after planting. Keep the soil mellow and clear of weeds. Weeds take from the soil plant food that is needed for the crop. A pulverized surface or a fine mulch will conserve the moisture during a drought. Several garden crops may be grown during one

season on a deep, fine soil that has been treated with rich, well rotted manure. The demand for plant food upon the soil is great and the supply should equal the demand. Collect soils from some of the richest gardens in the district and test their qualities. Find out why some people have better gardens than others. Have pupils make a plat of their gardens; show by lines and names where each kind of seed is planted. Have them plat model gardens to grow vegetables for family use. Plat five acres for commercial garden.

57. **Commercial Gardening.** Some vegetables perish quickly and are profitable only with ready access to market; others such as Irish potatoes, onions and cabbage, can be shipped long distances. Raise the best quality of vegetables, select the best varieties and use seed known to be good. In the garden, as in everything, the best is the most economical. Forcing beds and hot houses are used to produce very early vegetables. Such vegetables command good prices. This kind of gardening, managed properly pays well. It pays to plan well. Managing ability is worth more than land. Tell in writing how to make a hot bed. (Suggestion. In case it is too expensive to use glass for a cover, domestic painted with linseed oil, will answer.) Find the average yield per acre of the Irish potato crop in your district. What are the returns per acre, at 35 cents per bushel? Find the same for turnips and sweet potatoes. Name the three most profitable garden vegetables raised in the district. The report of a garden containing two and a quarter acres near Paris, as given by Hunnicutt, is as follows:

Vegetables sold in one season		$13,640.00
Annual rent paid	$ 500.00	
Paid for labor	5,500.00	
Paid for manures	1,500.00	
Sundry expenses	250.00	
Interest on capital	750.00	
Total Expenditures		8,500.00
Annual Profit		$5,140.00

58. **Enemies of Gardens.**—Cabbage worms, plant lice, squash bugs, cut worms, rust and potato scab are the worst. Cabbage worms may be destroyed by using Paris green; plant lice by using a kerosene emulsion; squash bugs must be picked off by hand and killed. They are especially fond of the squash vine. Plant squash among other melons. The bugs will collect on the squash vine where they may be destroyed. Cut worms may be destroyed by frequent cultivation which brings them to the surface where they will be eaten by birds. Spray with Bordeaux

mixture for rust and leaf blight; soak seed potatoes in a solution of formalin for potato scab. Make a list of vegetables of which the seed are used for food; the stalk; the root.

VI. STUDY OF INSECTS.

59. **Characteristics.**—Insects are divided into three parts, the head, the thorax, and the abdomen. They breathe by means of air tubes, not by means of lungs; the blood is clear and cold and the skeleton is on the outside of the body. Some of them live on land, some in water; some have wings, others have none; some move by jumping, some by walking, some by flying; some bite and chew their food while others suck it. Name the common insects of the community and classify them according to the above statements. It is difficult to determine whether insects do more harm than good. Insects (1) destroy crops, (2) convey disease by poisoning food, (3) cause disease by biting and stinging, (4) injure stock, (5) injure buildings, (6) are annoying in many ways. Insects (1) serve as scavengers, (2) fertilize flowers, (3) kill injurious insects, (4) are used in medicine, (5) furnish dye-stuff, (6) furnish material for making ink, (7) supply material for food, (8) supply material for clothing. Give example of each of the above. The damage done by insects in this country and Canada is estimated at nearly four hundred million dollars annually. How much damage was done by them in your school district last year? What profit were they to the district?

60. **The Grasshopper.**—Note its color, its method of locomotion. Name its enemies, its food, and the injury which it does. Note the shape of head and how attached to body; number of feelers and how attached to head. Find the jaws. Note shape of thorax. What parts are joined to it? Compare the outer and inner wings in size, shape, color, texture, position and use. Note the number, arrangement and mode of attachment of legs. How does it use its legs when it is walking? How does it keep from slipping when it jumps? Compare the abdomen in length and size with the thorax. Count rings on the abdomen. Watch a grasshopper breathe; which part of the body does it use? Could you kill a grasshopper by holding its head under water? Where do grasshoppers lay their eggs? If possible, secure some of their eggs for study. Name the damages done by grasshoppers. It is estimated that they damage the farmers of the United States over $50,000,000 annually. Its enemies are birds, toads, snakes and turtles.

61. The Honey Bee.—Follow plan of study of the grasshopper. Note carefully how many pairs of wings it has. The tongue of the bee can be twisted like the trunk of the elephant. It has a small brush on the end with which it sweeps the nectar out of the flowers. The nectar is stored in a honey-bag, and when it is full, the bee goes home and stores it away. Name the favorite blossoms from which honey is gathered. What is the queen? A drone? A worker? In a hive there is one queen, from five hundred to one thousand drones and twenty thousand workers. The queen sometimes lays as many as two thousand eggs in a day. The average life of the worker is about six weeks; the queen lives sometimes five years. What becomes of the drones? What is "bee bread?" "Brood comb?" What causes bees to swarm? Name the divisions of labor in a bee hive. What protection should be given the hive during winter? How much honey is made in an ordinary hive and what is it worth per pound? How is bees-wax prepared? Name its uses.

62. Mosquitoes.—The eggs of the mosquito are found on the surface of stagnant water. They hatch in a day and are known in the young stage as "wrigglers." It takes from one to two weeks for them to develop into mosquitoes. One female will lay from two hundred to four hundred eggs in a day. Put some water containing "wrigglers" in a glass jar and cover with a piece of gauze or cheese cloth. When mosquitoes appear, put in a few drops of coal oil and notice result. Why should stagnant pools be drained? If it is impossible to drain such places, how can the mosquitoes be killed? Put some water containing "wrigglers" in a glass jar in which there is a sun fish, perch, bass, shiner or gold fish. Note the number of "wrigglers" the fish will catch. Toads, fish, swallows and dragon flies devour large numbers of misquitoes. What diseases are supposed to be spread by means of these insects?

63. Well-Known Insects.—(a) Note color, color of wings and odor of the chinch bug. Name plants upon which it feeds. They winter in straw, weeds, brush and rubbish. Will they do more harm during a wet season or a dry one? Why? Destroy chinch bugs by burning the weeds, straw and rubbish in which they have hid for the winter. They seldom fly but usually crawl. If a deep furrow is ploughed around a crop, but few will be able to pass it. Dragging a log in the furrow will kill many and at the same time pulverize the soil and render it more difficult to cross. (b) Compare size of head of the squash bug with body. Note the sharp beak and how it is bent. Does it jump, crawl or

run? Note the odor. It lives upon the juices of plants. How does it obtain its food? It is difficult to kill these bugs. A small board laid near a young plant will furnish night shelter; they will collect under it and can be killed every morning. (c) Where is the dragon fly usually found? How many pairs of wings? Are they weak or strong? Note the position of its wings when at rest. Note its power of flight. It lays its eggs in water and feeds upon insects. Has it a sting? Is it dangerous? Is it harmful or helpful to man?

VII. STOCK-RAISING AND FEEDING.

64. **Mixed Farming.**—All farmers should be stock farmers. Stock raising and stock feeding are the most profitable kinds of farming. Few farms in Missouri can be made most profitable without stock raising or stock feeding. The chief aim in stock-farming is to feed the grain and grass crops to stock instead of selling it. The principal animals produced in Missouri are, (1) horses and mules, (2) cattle, (3) hogs, (4) sheep and (5) poultry. Accurate information about stock and care in handling are necessary to success in this industry. Stock should be protected from rain and cold by being housed in a good warm stable which should be well lighted and ventilated. The floor should be raised six or eight inches that it may be kept dry. Clay, when once thoroughly hardened, makes an excellent floor; cinders and gravel make good floors; board or concrete floors are good when covered with straw. Any kind of floor should be cleaned often; the cleaner the stables are kept, the healthier will be the animals. After talking with some of the best farmers of the district, write a description of a model 80 acre farm and describe the character of the grain, grass and stock that may be produced thereon.

65. **Stock-Feeding.**—The art of feeding is knowing how to furnish the proper kinds and amounts of food. The rations should be regular in amount and quality, and selected according to the age of the animal and purpose for which it is fed. Change of ration and regularity as to time of feeding are as necessary for animals as for men. To over-feed an animal is as bad as to under-feed it. Explain pasturing; stall-feeding; "roughing." An abundant supply of good water is necessary. Muddy water often found in ponds may be full of germs that produce disease in stock and may produce disease germs in milk.

Scrub stock does not pay; it requires as much feed, space and attention as the best grade and the profits are not so great. By means of experimenting, discover a proper ration for as many different kinds of stock as possible. Make permanent record of results. Enlist parents in these experiments. Write to Agricultural College, Columbia, Mo., for bulletin on Stock-feeding.

66. **Horses and Mules.**—The three general classes of horses are (1) the draft horse, (2) the coach horse and (3) the roadsters. There are many breeds and cross-breeds in each class. Draft horses have short legs, heavy bodies, short thick necks, broad, deep chests and shoulders, wide hocks and large feet. They weigh from 1500 to 2100 pounds. The most familiar breeds of this class are the Percherons, the Clydesdale and the English Shire. The Percherons came from France; they were originally gray but now they are generally black or dark brown. The Shires came from England; the common color is bay or brown, though some are sorrel. They usually have some white in the face and always have long hair on the fetlocks; they are slow but very strong. The Clydesdales came from Scotland. They are similar to the Shires in form and color. They are somewhat smaller and more active than the Shires. Coach horses are most beautiful in form. They have round, well, proportioned bodies, long, arched necks and fine, well-shaped heads. They weigh from 1200 to 1600 pounds. Their long legs make them desirable for road work. They are able to draw heavy carriages and coaches. The German Coach, Hackney and French Coach are the most common of this class. Roadsters include saddle horses, trotters, thoroughbreds (running horses) and other horses of light weight. This class of horses has long, thin necks, narrow chests, long backs and long legs; they have hard, strong muscles and tendons. The running horse was developed in England; the trotter and saddler in America. A good horse must have good feet. "No foot, no horse" is true. The feet should receive careful attention; the bottoms should be cleaned every day, the hoofs should be kept free from mud and greased every two weeks. Great care should be taken in shoeing horses. Horsemen are careful to ask if a horse has a good mouth; by this is meant that he will pull against the bit and at the same time is easy to handle. Unless a horse pulls against the bit, he can not be considered a good saddler or driver. The classes of mules are (1) the farm mule, (2) the miner's mule, (3) the cotton mule, (4) the cane mule and (5) the army mule. Give the characteristics of each. The mule is healthy, easily kept, strong and valuable. Name two large mule markets. What is

year. Make and solve some problems relating to marketing poultry and poultry products. Find out if possible the value of the poultry products of your district; of your county.

71. **Breeds of Chickens.**—They may be classed as (1) setters, (2) non-setters, (3) general purpose and (4) game. The setters include the Cochins, the Brahmas and the Langshans, known as the Asiatic breeds. They are large, gentle and mature early. The non-setters include the Leghorns, Minorcas and Spanish, known as the Mediterranean breeds. They are small, good foragers and fine for laying. The general purpose chickens include the Plymouth Rocks and Wyandottes, known as the American breeds. They are of medium size, good layers and good mothers. The game chickens include several breeds that are much prized by fanciers but are not valuable in poultry markets. Standard bred chickens have been brought to a high state of development by careful and skillful management. They suffer from neglect and unhealthful surroundings. The common chicken is able to stand neglect better than any well bred variety. It is hardy and able to shift for itself. Find pictures of as many different kinds as possible and study characteristics of each. What breeds are best? That depends upon circumstances. Not all breeds do equally well under all circumstances. The amount of ground used for poultry yard, the purpose for which chickens are raised and other conditions must be considered when deciding upon the breed.

72. **Care of Chickens.**—Chickens should be provided with a house separate from other buildings. Drain water away from it. The house need not be expensive. If it is covered with a shed roof, it should slope to the north in order to give as much sunlight as possible on the south side. There should be windows in the south side to admit plenty of sunlight during the winter. There should be two apartments, one for nests and the other for roosting. Fill with sand, cinders or clay until the floor is a few inches higher than the ground around it. The house should be kept clean, dry, thoroughly ventilated, sprinkled often with lime or crude carbolic acid and whitewashed once a year. Chickens need plenty of fresh air, but should be well protected from cold in winter; hens will not lay during cold weather unless they have warm, comfortable quarters and the proper kind of food. Chickens need a variety of food; corn, chop, wheat, oats, sunflower seed and green vegetation are suitable. Crushed bones and oyster shells, gravel and pieces of broken pottery should be kept in their yard; lime should be given to laying hens. Experiment with different kinds of foods and

discover the best food for them at different times of the year. Probably fifty per cent of young chicks die before they are eight weeks old. This is probably due to over-feeding, withholding water at proper time and lack of sufficient and proper grit. Young chicks should not be fed for forty-eight hours after hatching. Feed a little at a time, but feed often. Keep plenty of good water where they can get it easily. A thirsty chick drinks too rapidly and too much. Coarse sand is good grit for young chicks. Young chicks must be protected against their enemies and from rain. It pays to have dry coops for them. Write an essay on "Caring for Young Chicks."

73. Moulting and Diseases.—(a) Chickens are not so profiitable during the moulting period which begins about the first of September and continues for three or four months. Poultry raisers overcome this in a measure by artificial methods. Chickens are penned up for two weeks, during the first of July and are fed little, if anything, but are given plenty of water. This reduces the flesh. They are then let out and fed well. The fasting causes them to begin moulting and the good feeding which follows starts a new growth of feathers. By this process, moulting is finished in a few weeks and chickens begin laying early in the fall and continue during cold weather when eggs are most valuable. Try this experiment and write the results. Painstaking pays with chickens as well as in every other farming business. (b) Some of the most prevalent chicken diseases are roup, cholera, heavy breathing and rattling. The causes of roup are damp, poorly ventilated houses, bad food and filthy water. The best preventive of roup is the removal of the causes. There is no certain remedy for roup or cholera. A chicken that has either should be killed at once and the carcass burned or buried deep. For rattles and heavy breathing, mix a table spoon full of kerosene in a gallon of water for them to drink. Twelve drops of aconite to a quart of water is also a good remedy and chickens will drink it more readily.

REFERENCE BOOKS.

Note—The following list contains only a very few of the many valuable reference books on agriculture. These books may be obtained through any book dealer or may be had by writing directly to the publisher.

NAME OF BOOK.	AUTHOR.	PUBLISHER.
First Principles of Agriculture,	Vorhees,	Silver, Burdett & Co.
Practical Agriculture,	James,	Appleton.
Agriculture for Beginners,	Burkett, Stevens & Hill,	Ginn & Co.
Elements of agriculture.	McBryde.	Johnson Publishing Co. Richmond, Va.
Agriculture for Common Schools.	Hunnicutt.	The Cultivator Publishing Co., Atlanta, Ga.
New Elementary Agriculture.	Bessey, Bruner & Swezey.	University Publishing Co., Lincoln, Neb.
The Soil.	King.	McMillan & Co.
Judging Live Stock.	Craig.	J. A. Craig, College Station, Tex.
Feeds And Feeding.	Henry.	W. A. Henry, Madison, Wis.
First Principles of Agriculture.	Goff & Mayne.	American Book Co.

FARMERS' BULLETINS

(U. S. Department of Agriculture, Washington, D. C.)

Note—This is a popular series of bulletins printed for free distribution and in the following list only a few of the more important numbers are given. A complete list of all the Farmers' Bulletins will be found on the last page of each of the bulletins. The bulletins are printed for free distribution and may be had by making application to any United States senator or representative in Congress, or to the Secretary of Agriculture, Washington, D. C. In writing for these bulletins be sure and ask for FARMERS' BULLETINS, as there are several series of bulletins of the Department of Agriculture.

16, Leguminous Plants; 21, Barnyard Manure; 24, Hog Cholera and Swine Plague; 28, Weeds: And How to Kill Them; 31, Alfalfa or Lucern; 32, Silos and Silage; 33, Peach Growing for Market; 34, Meats: Composition and Cooking; 35, Potato Culture; 36, Cotton Seeds and its Products; 37, Kafir Corn: Culture and Uses; 39, Onion Culture; 44, Commercial Fertilizers; 48, The Manuring of Cotton; 49, Sheep Feeding; 50, Sorghum as a Forage Crop; 51, Standard Varieties of Chickens; 52, The Sugar Beet; 53, How to Grow Mushrooms; 54, Some Common Birds; 55, The Dairy Herd; 57, Butter Making on the Farm; 58, The Soy Bean as a Forage Crop; 61, Asparagus Culture; 63, Care of Milk on the Farm; 64, Ducks and Geese; 66, Meadows and Pastures; 70, Insect Enemies of the Grape; 74, Milk as Food; 75, The Grain Smuts; 76, Tomato Growing; 80, The Peach Twig-borer; 86, Thirty Poisonous Plants; 89, Cowpeas; 91, Potato Diseases and Treatment; 93, Sugar as Food; 95, Good Roads for Farmers; 96; Raising Sheep for Mutton; 99, Insect Enemies of Shade Trees; 106, Breeds of Dairy Cattle; 109, Farmers' Reading Courses; 111, Farmers' Interest in Good Seeds; 112, Bread and Bread Making; 113, The Apple and How to Grow It: 121, Beans, Peas and Other Legumes as Food; 123, Red Clover Seed: Information for Purchasers; 126, Practical Suggestions for Farm Buildings; 128, Eggs and Their Uses as Food; 132, Insect Enemies of Growing Wheat; 134, Tree Planting in Rural School Grounds; 136, Earth Roads; 141, Poultry Raising on the Farm; 154, The Fruit Garden: Preparation and Care; 155, How Insects Affect Health in Rural Districts; 157, The Propagation of Plants; 161, Practical Suggestions for Fruit Growers; 164, Rape as a Forage Crop; 166, Cheese Making on the Farm; 170, Principles of Horse Feeding; 171, The Control of the Codling Moth; 173, Primer of Forestry; 175 Home Manufacture and Use of Unfermented Grape Juice; 177, Squab Raising; 182, Poultry as Food; 183, Meat on the Farm—Butchering, Curing, etc.; 184, Marketing Live Stock; 188, Weeds Used in Medicine.

MISSOURI STATE BOARD OF AGRICULTURE

NOTE—A Monthly Bulletin is issued from the office of Secretary of the State Board of Agriculture and may be had free by addressing the Secretary, Columbia, Missouri. The Annual Report of the Board of Agriculture, containing the proceedings of the Board, a report on farmers' institute work, the State veterinary work and a number of valuable papers on different subjects relating to agriculture, stock breeding, feeding, fruit growing, etc., may be had free by making application to the Secretary, Columbia, Missouri.

The following list contains a few of the many bulletins that will be interesting in school work:

Road Dragging.
State Dairy Association.
Improved Live Stock Breeders' Association.
Corn Growrs' Association.

Peach Growing in Missouri.
Strawberry Growing,
Grape Growing for Home Use.
Alfalfa Growing.
The Egg Producing Hen.

AGRICULTURAL COLLEGE.

NOTE—The Bulletins of the Agricultural College are not issued at any stated time, but are usually published at the close of an experiment in a given line of work and may be had by addressing the Dean of the Agricultural College, Columbia, Missouri.

Only a few of the important numbers are given below:

Apple Growing in Missouri.
Pruning the Peach.
Spray Calendar.
The Dairy Cow.
Principles of Plant Production—The Seed.
Plant Propagation.
The Chinch Bug.
Insect Enemies of Wheat.

STATE HORTICULTURAL SOCIETY.

NOTE—The Annual Report of the State Horticultural Society which contains a great many valuable papers on practical horticulture may be had by addressing Secretary L. A. Goodman, 4000 Warwick Boulevard, Knasas City, Missouri.